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BACTERIOLOGICAL INVESTIGATIONS OF THE UPPER SOUTH PLATTE RIVER BASIN. MAY 1972, JULY 1972, SEPTEMBER 1972

Environmental Protection Agency
Denver, Colorado

December 1972

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SURVEILLANCE AND ANALYSIS DIVISION

ENVIRONMENTAL PROTECTION AGENCY

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REGION VIII
DECEMBER, 1972

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SECTION I

Summary

The Region VIII EPA office has proposed upgrading the South Platte River above Denver, Colorado from Class "A" to Class "B_3" to provide for body-contact water recreation. To determine if the present water quality is within the proposed compliance level (B_3 - average of 100 fecal coliform/100 ml) three field surveys were conducted on a 13 mile reach of the river during different flow conditions and different seasons of the year. Results from these surveys indicate that the proposed upgrading to Class "B_3" is feasible if several abatement actions are taken. A tributary stream, Bear Creek, was found to be highly contaminated with fecal coliform originating from the area of Evergreen, Colorado.

SECTION II

Introduction

Headwaters of the South Platte River originate on both the east slope of the Rocky Mountains and also on the west slope via transbasin diversions. A portion of this high quality water is impounded in storage reservoirs upstream of major urban areas and the remainder flows directly down to Denver through the Platte Canyon. As the water flows toward the highly urbanized Denver Metro area it is impacted by increasing numbers of waste discharges and natural tributaries.

The South Platte River upstream from Denver is presently used for body contact recreation (wading, swimming, and tubing), and additional water-oriented recreation projects are proposed (Littleton Flood Plain Park) or under construction (Chatfield Dam and Reservoir). Although the river is used for body-contact recreation, the present stream classification (Class "A") does not provide for such use. The present Class "A" stream classification provides for a bacteriological quality in the river "not to exceed a log-mean fecal coliform density of 1000 per 100 ml or 2000 per 100 ml in more than 10% of the samples collected in any 30 day period" (Ref. 1). Water of this quality is not currently recognized as being safe for body-contact recreational use.

In a continuing movement toward improved water quality, the South Platte River Basin has been selected as one of Region VIII's highest priority areas for an abatement and control program (Ref. 2). Accordingly, it is a primary regional objective to upgrade the classification of the South Platte River upstream from Union Avenue in Littleton, Colorado, to the "B_3" level - that which safely permits body-contact water recreation. This "B_3" classification calls for a bacteriological standard as follows:

"Total coliform density shall not exceed 1000 per 100 ml as a monthly average or exceed this number in 20 percent of the samples examined during any month; nor exceed 2400 per 100 ml in a single sample. The fecal coliform shall not exceed 100 per 100 ml and fecal streptococcus shall not exceed 20 per 100 ml, both of these fecal coliform limits are to be the average of five consecutive samples within a month" (Ref. 1).

SECTION III

Study Description and Field Procedures

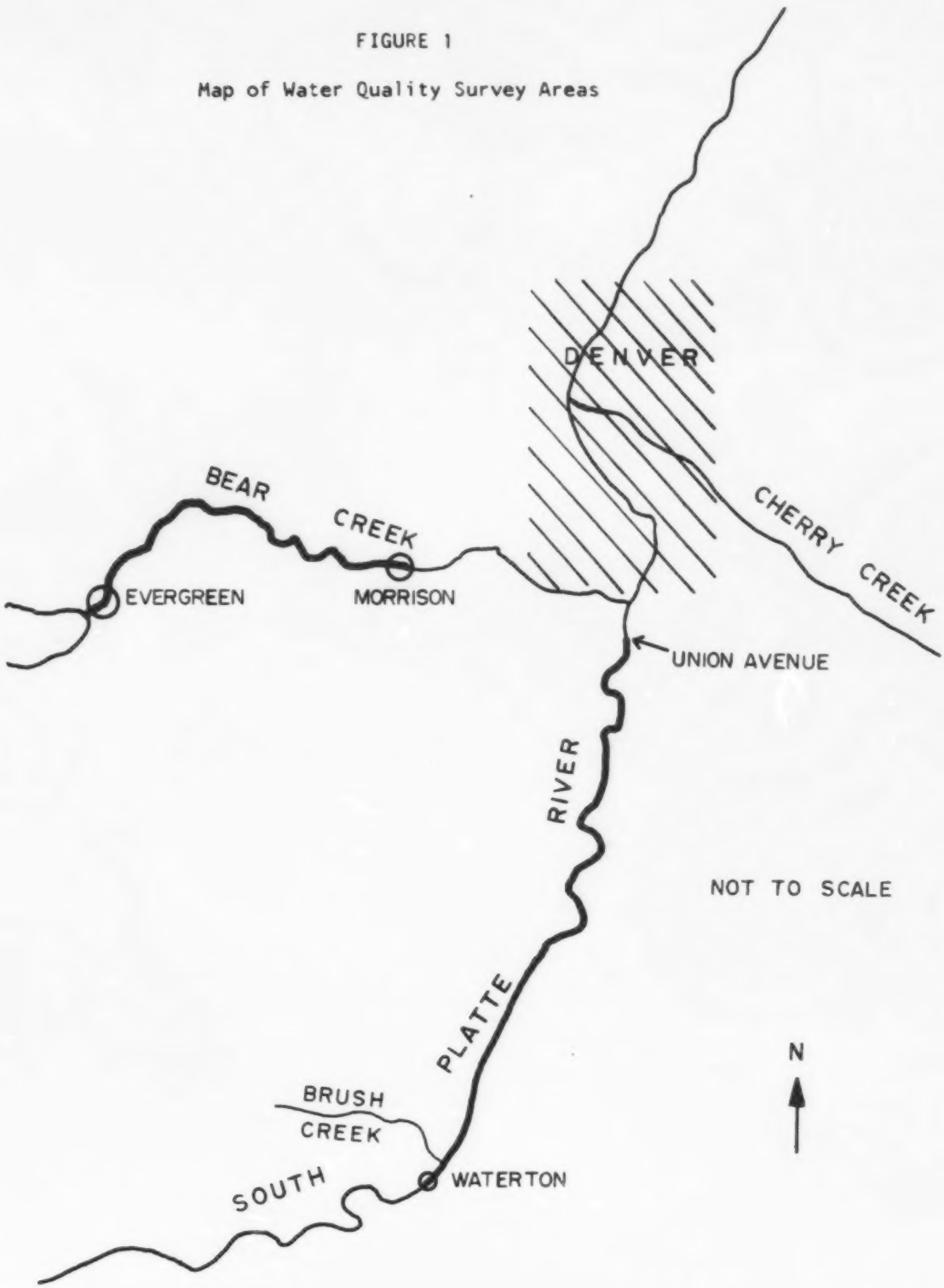
There is a small amount of existant data which indicates that the bacteriological quality of this 13 mile reach of the South Platte River may be less than the "B_3" compliance level. Therefore, the Region embarked on a field study program to accurately determine bacteriological quality during different flow conditions and different seasons of the year. The basic objective was to determine whether, in fact, the bacteriological quality was within the compliance level or whether reduction in total and fecal coliform levels is required by abatement and control actions.

Field surveys were conducted in May, July, and September, 1972, as a part of the study program. Each of the three surveys covered the 13 mile stretch of the South Platte River from Union Avenue to Waterton, Colorado (RM 328 to 341). The general study area is depicted in Figure 1 which shows the South Platte River and several tributaries in the Denver Metropolitan area. The first study was initiated during May in conjunction with an in-plant survey at the Littleton Sewage Treatment Plant. The timing of the survey also coincided with a relatively high flow condition on the South Platte River (about 200 cfs near the treatment plant). Sampling occurred on May 15, 16, 18, 22, and 23. A total of 20 river samples were collected from four sample locations within the reach and one sample site downstream from river mile 328. At each sample location daily grab samples were taken using a sterile 250 ml wide-mouth bottle. Each sample was identified with the following field data: station number, temperature, time, and remarks; e.g., depth and visual condition of water being sampled, chlorine content, etc. The samples were then analyzed for total and fecal coliforms by the millipore filter technique at the Littleton Sewage Treatment Plant.

A second, more intensive study was conducted during July to gather additional bacteriological data at lower flow conditions as well as to locate and sample all significant waste discharges to the river. It was determined after the survey, however, that the river flow during the survey averaged about 210 cfs, or slightly more than during the May survey. Approximately 25 separate discharges were identified during a foot reconnaissance of the 13 mile study area conducted in conjunction with the water sampling on July 12, 13, 14, 17, 18, 19, and 20. Of these 25 discharges only seven were considered significant enough to warrant sampling. In order to determine the bacteriological impact on the river from these seven discharges, river samples were collected above and below the individual discharge points. In total, 120 river samples and 3 Brush Creek (tributary stream) samples were collected from

FIGURE 1

Map of Water Quality Survey Areas



20 locations during the July survey.

The final survey was initiated during the last week of September to provide additional bacteriological data during low flow conditions. USGS flow measurements indicate that river flow averaged about 46 cfs during the survey. Sampling was conducted from September 25 to 29 with a total of 50 samples collected at 11 locations on the South Platte River, Bear Creek, and Brush Creek. Most of the South Platte and Brush Creek locations had been previously sampled during the May and July surveys, but the Bear Creek locations were being sampled for the first time. The Bear Creek samples yielded fecal coliform counts of sufficient magnitude to warrant a closer look at bacteriological conditions in the stream. Therefore, a one day sample run was made on October 5 covering 12 Bear Creek locations between Morrison and Evergreen, Colorado.

Each of the three South Platte River surveys included sample stations which are sampled periodically by the Denver Water Board and/or the Denver Regional Council of Governments. These stations include the following:

SP-7	Bowles Avenue Bridge
SP-25	Highway 470 Bridge
SP-30	Waterton USGS Stream Gaging Station

All sampling locations for these surveys are shown on the map in Figure 2 and are described in Table 1 in Appendix B.

SECTION IV

Results and Discussion

General

The findings of the foot reconnaissance conducted during the July survey help to explain the bacteriological results from each of the three surveys. This reconnaissance pinpointed the location of about 25 discharges to the South Platte River in the 13 mile study area. The majority of these discharges were attributable to irrigation return flow from residential areas, agricultural areas, parks, and golf courses. These flows were estimated to range from 5 to 75 gpm. Sampling for bacteriological analysis was conducted at seven locations during July where discharges were thought to have a significant impact on the river water quality. These discharges included the following:

1 - 5 to 10 gpm of surface runoff from the horse barns at the Centennial Racetrack grounds just upstream from Belleview Avenue. Located between stations SP-2 and SP-3.

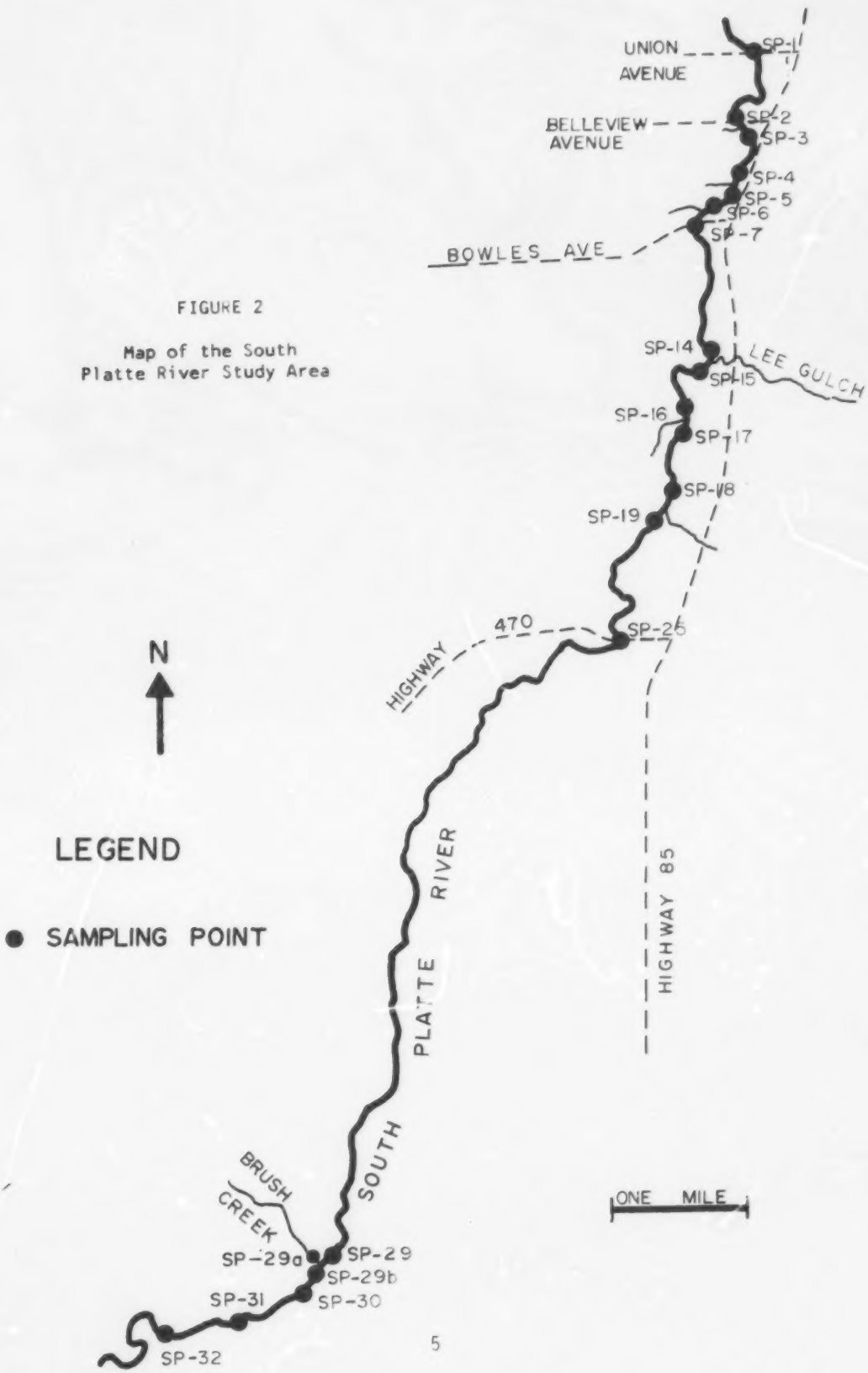


FIGURE 2

Map of the South
Platte River Study Area

2 - 20 gpm of irrigation return flow located 100 yards upstream from the Crestline Avenue bridge. Located between stations SP-4 and SP-5.

3 - 20 gpm of irrigation return flow located just upstream from the Littleton water storage ponds. Located between stations SP-6 and SP-7.

4 - Lee Gulch containing an estimated flow of 100 - 150 gpm. Located between stations SP-14 and SP-15.

5 - A small moss-choked creek carrying 100 - 150 gpm through farm and pastureland upstream from the Bowles Avenue bridge. Located between stations SP-16 and SP-17.

6 - 75 gpm of irrigation return flow just upstream from the Cooley Gravel Company bridge. Located between stations SP-18 and SP-19.

7 - Brush Creek, containing an estimated flow of 100 gpm, most of which is wastewater from the Martin Marietta Company. Located between stations SP-29 and SP-30.

Another significant discharge noted in September but not sampled was the effluent from the filter sand washing operation at the Kassler Water Treatment Plant at Waterton. It consisted of about 75 gpm of highly turbid wastewater which has caused silt buildup for 100 yards or more along the north bank of the South Platte River. This discharge is in violation of the State of Colorado Narrative Water Quality Standard (Section B) which states that all waste must be "free from substances that will form objectionable bottom deposits" (Ref. 1). Two gravel washing operations (Peter Kiewit and Sons and Cooley Gravel Company) also discharge small, fairly clear wastewater flows to the river just below the Highway 470 bridge (SP-25).

Comparison With Present Class "A" Standard

The findings of the foot reconnaissance presented above explain many of the irregularities evident in Figures 3, 4, and 5 showing coliform concentrations vs. river miles for each of the three surveys. Figure 3 and Table 1 present the results of the May survey where coliform concentrations are log-mean values and river miles begin with zero at the Union Avenue bridge (SP-1) and increase in the upstream direction. A degradation of water quality in passing from upstream to downstream stations is evident from Figure 3. This is expected because of increasing urbanization and the associated surface discharges noted in the foot reconnaissance. Table 1 in Appendix A shows that on May 18 an unusually high total coliform count was obtained for some unexplained reason at the Bowles Avenue station (SP-7). This caused the log-mean total coliform value at Bowles Avenue to be higher than the downstream station at Union Avenue (SP-1) (See Figure 3).

FIGURE 3

Log-Mean Total and Fecal Coliform Concentrations vs
River Miles For May, 1972 Survey

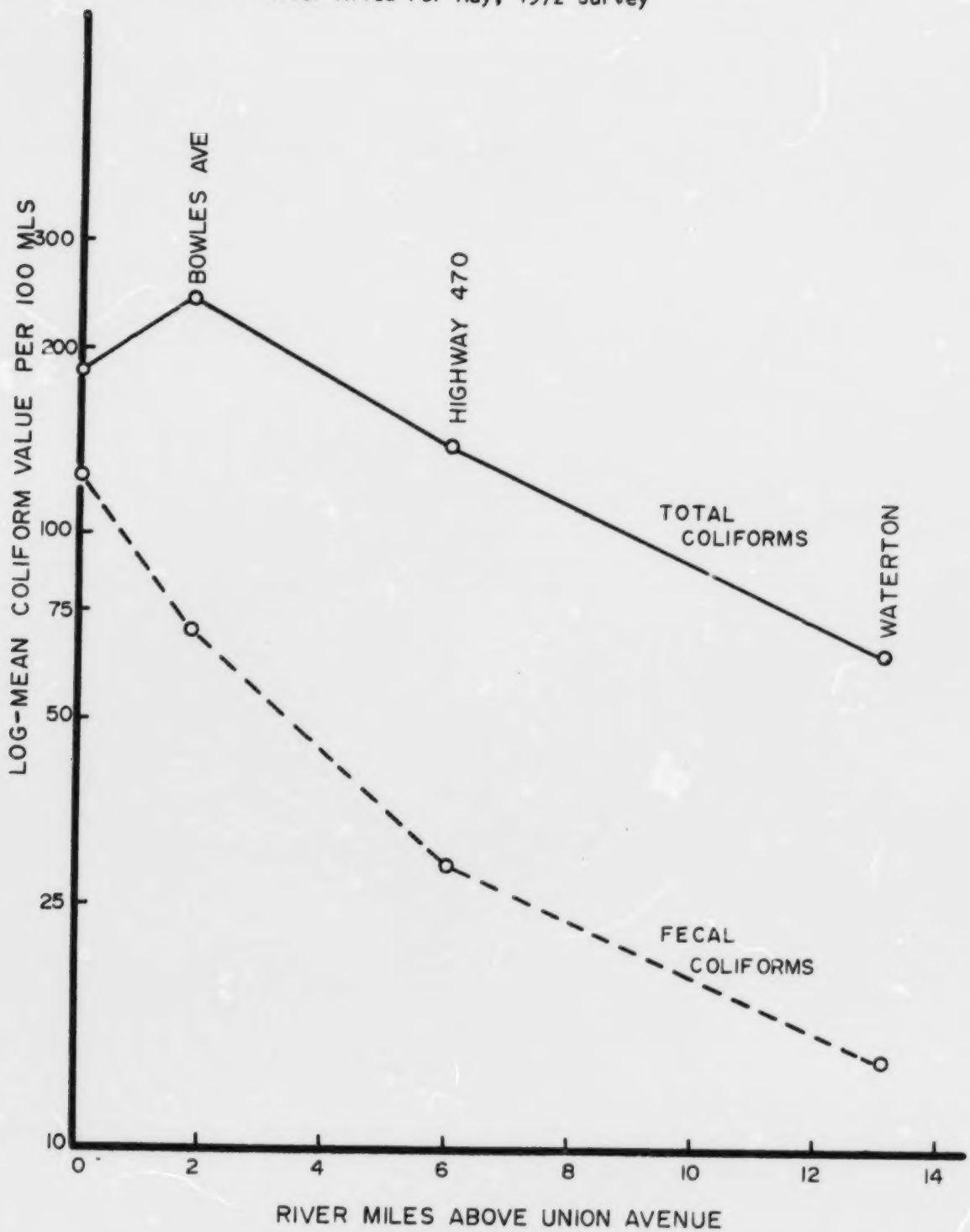


TABLE 1

SUMMARY OF TOTAL AND FECAL COLIFORM CONCENTRATIONS FOR SELECTED STATIONS ON THE SOUTH PLATTE RIVER - SURVEY OF MAY, 1972

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
SP-0	3	5600	180	566	3	480	27	128
SP-1	2	200	170	184	2	170	90	124
SP-7	5	1100	72	241	5	130	45	70
SP-25	5	280	47	139	5	110	5	29
SP-30	5	270	10	64	5	30	<5	14

Approved Colorado water quality standards for the South Platte River upstream from the Union Avenue bridge (SP-1) specify that "fecal coliform densities must not exceed a log mean value of 1000 per 100 ml nor 2000 per 100 ml in more than 10% of the samples collected in any 30 day period" (Ref. 1). This bacteriological standard (Class "A") was not exceeded at any station during the May survey.

The results of the July survey are presented in Figure 4 and Table 2. Figure 4 shows that fecal and total coliforms were higher at the upper and lower stream reaches than in the middle.

As mentioned earlier in discussing the May survey, the lower stream reach is affected by increasing urbanization and the associated surface runoff from irrigation and other sources. The discharges noted in the foot reconnaissance impact the river and produce the erratic plot shown in Figure 4. The bacteriological quality of the upper stream reach is affected primarily by Brush Creek (carrying Martin-Marietta Company wastewater) and other undefined sources further up the South Platte Canyon. Although increased coliform levels were found in both the upper and lower stream reach, the approved (Class "A") Colorado water quality standard was not exceeded during the July survey.

The results of the September survey are presented in Table 3 and shown graphically in Figure 5. As in the July survey a trend can be observed which shows higher coliform levels at the upper and lower stream reaches than in the middle. Again, this increase in the lower stream reach (around Bowles Avenue) is due to increased urbanization and associated runoff, while the upper reach appears to be most affected by the discharge from the Martin Marietta Company (in Brush Creek). In neither reach, however, were there sufficiently high coliform concentrations to produce violations of the present Class "A" bacteriological standard.

As mentioned earlier, a one day sample run covering 13 stations was made on October 5 on Bear Creek between Morrison and Evergreen, Colorado. These stations are located on the map in Figure 6 and are described in detail in Table 2 in Appendix B. The survey was initiated to try to determine the cause of the high fecal coliform counts (2600 per 100 ml) observed at Morrison during the South Platte River survey of July, 1972. A summary of the bacteriological data is presented in Table 4 and has been used to plot coliform concentrations vs. river miles in Figure 7. The complete survey data is presented in Table 4 in Appendix A.

Except for stations BC-1 and BC-2, the data in Figure 7 is based upon only one bacteriological analysis at each station. However, the results in Figure 7 are quite clear - domestic wastes (in terms of fecal coliforms) from the Evergreen, Colorado, area cause gross pollution of Bear Creek for several miles downstream. The sewage treatment facility at Evergreen was evidently not providing adequate disinfection of the treated effluent on October 5. Increased operational efficiency and control (hopefully to be accomplished through a proposed plant expansion) is necessary at this plant if the present Class "A" compliance level for Bear Creek (less than a log-mean value of 1000 fecal coliforms per 100 ml) is to be achieved. There is currently no plan for upgrading Bear Creek above the "A" level.

FIGURE 4

Log-Mean Total and Fecal Coliform Concentrations vs River Miles For All Days During July, 1972 Survey

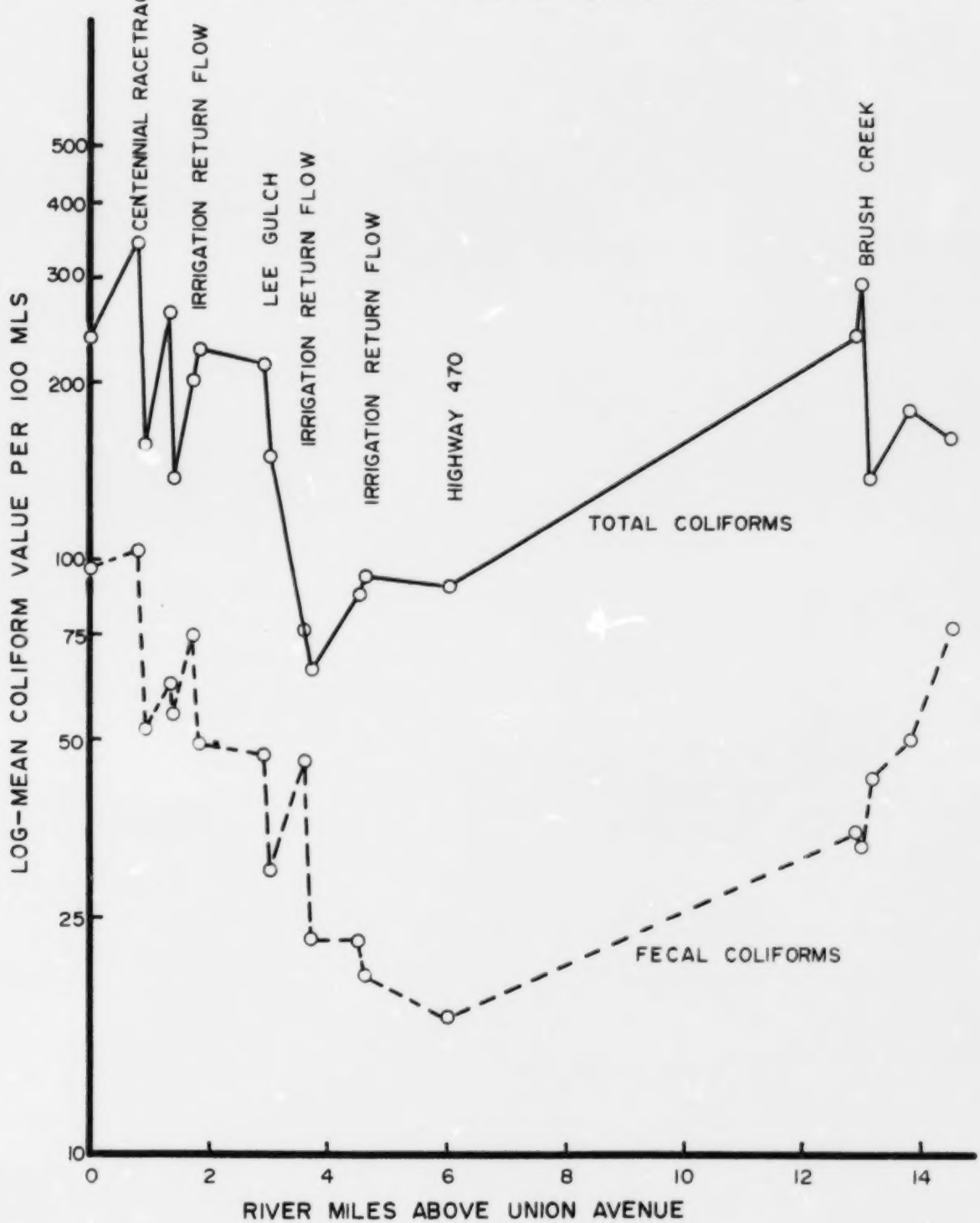


TABLE 2

SUMMARY OF TOTAL AND FECAL COLIFORM CONCENTRATIONS FOR SELECTED STATIONS ON THE SOUTH PLATTE RIVER - SURVEY OF JULY, 1972

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
SP-1	7	1200	100	238	7	230	30	97
SP-2	7	5700	65	345	7	1300	28	103
SP-3	7	320	67	157	7	72	30	52
SP-4	7	1800	110	265	7	180	19	62
SP-5	7	360	45	136	7	94	28	55
SP-6	7	450	68	201	7	200	39	75
SP-7	7	2700	34	227	7	260	8	49
SP-14	6	2100	46	214	6	250	25	47
SP-15	6	1700	18	150	6	57	15	30
SP-16	6	290	25	75	6	100	20	46
SP-17	6	210	16	65	6	80	8	23
SP-18	7	240	22	87	7	75	10	23
SP-19	7	830	17	94	7	130	2	20
SP-25	7	470	29	90	7	40	4	17
SP-29	6	2600	<4	238	6	150	<4	35

Table 2

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
SP-29-A	3	5400	140	1526	3	95	<4	29
SP-29-B	3	400	220	291	3	40	25	33
SP-30	7	290	40	137	7	110	16	43
SP-31	5	290	88	179	5	78	33	50
SP-32	5	330	68	159	5	150	51	77

FIGURE 5

Log-Mean Total and Fecal Coliform Concentrations vs River Miles For September, 1972 Survey

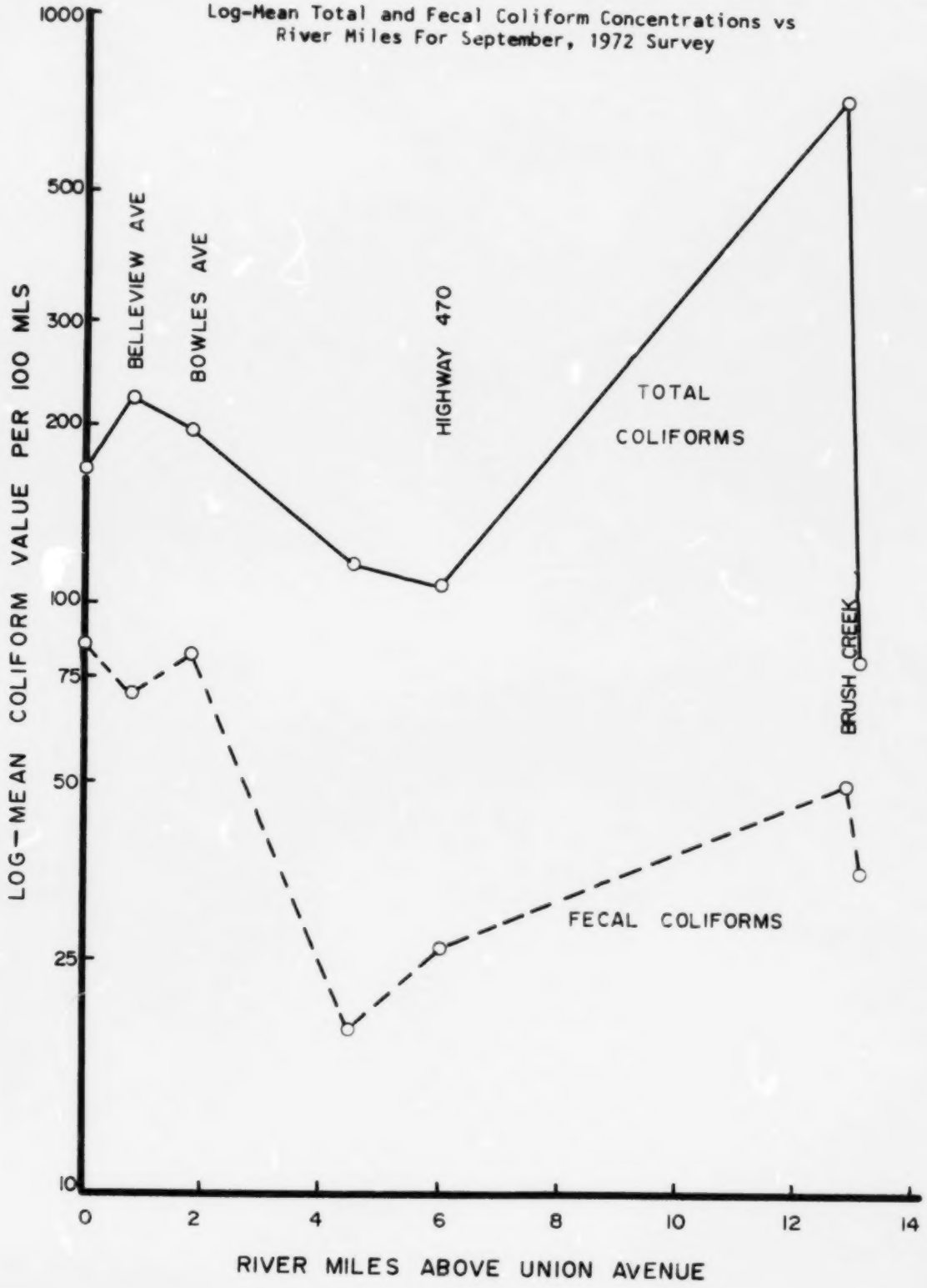


TABLE 3

SUMMARY OF TOTAL AND FECAL COLIFORM CONCENTRATIONS FOR SELECTED STATIONS ON THE SOUTH PLATTE RIVER - SURVEY OF SEPTEMBER, 1972

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
SP-1	5	330	92	169	5	320	40	85
SP-2	5	380	140	221	5	180	23	70
SP-7	5	450	68	196	5	170	36	82
SP-18	5	650	62	116	5	40	12	19
SP-25	5	160	44	106	5	40	14	26
SP-29	5	2700	100	712	5	130	25	49
SP-29-A	1	59	59	59	1	9	9	9
SP-30	5	110	61	80	5	76	12	35

FIGURE 6 Map of Bear Creek Study Area

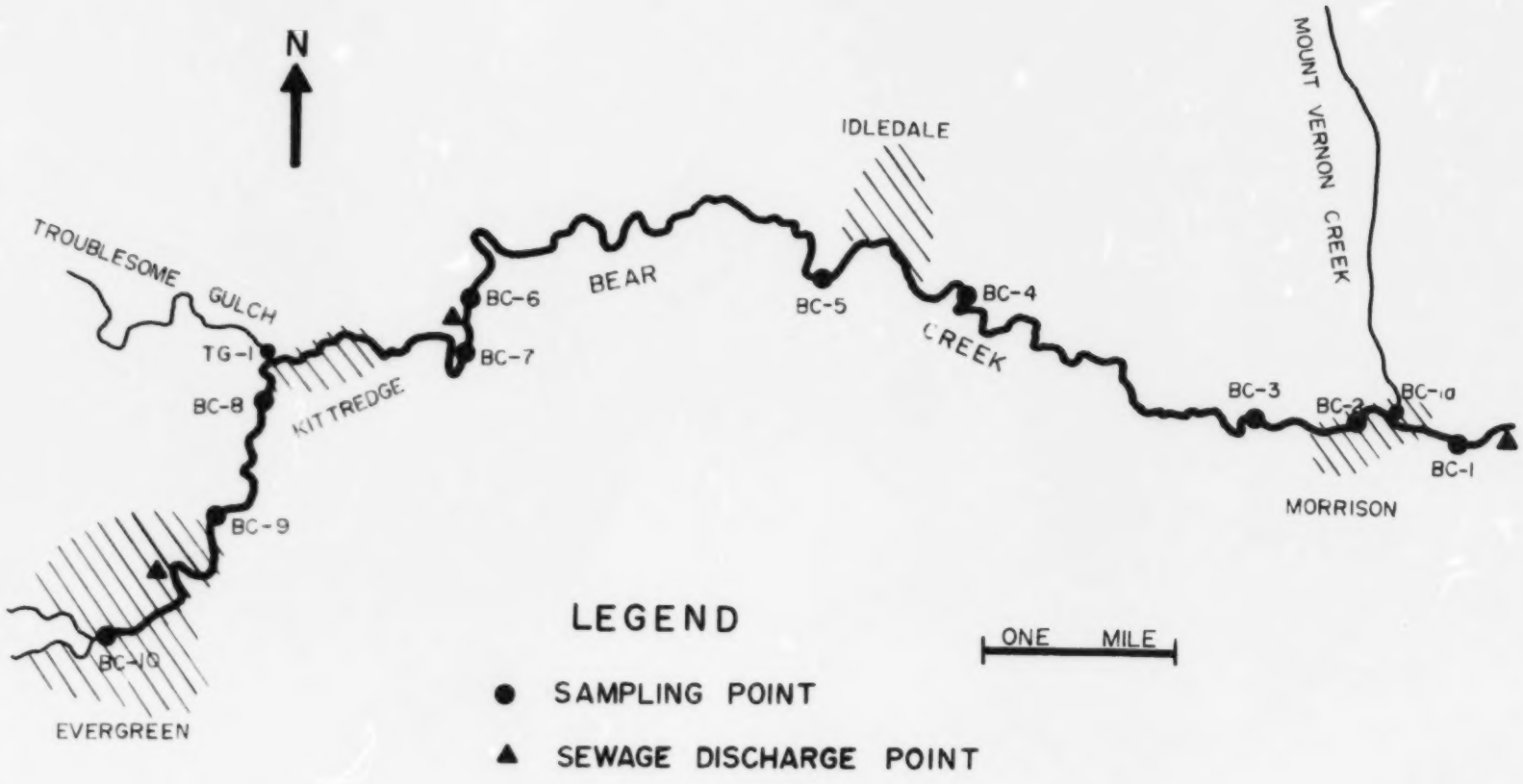


FIGURE 7

Log-Mean Total and Fecal Coliform Concentrations
vs River Miles For Bear Creek Survey

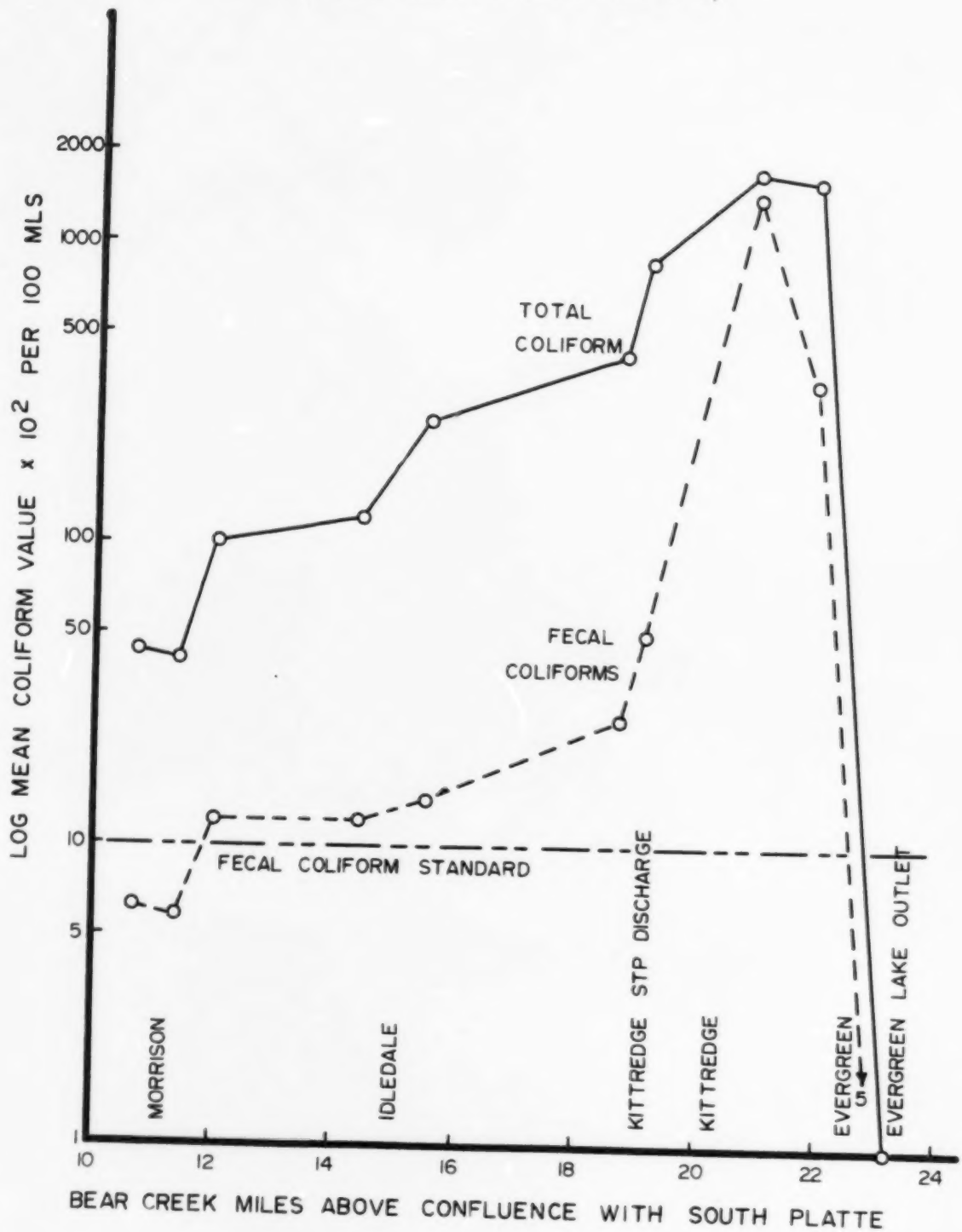


TABLE 4

SUMMARY OF TOTAL AND FECAL COLIFORM
CONCENTRATIONS FOR SELECTED STATIONS
BEAR CREEK SURVEY - SEPTEMBER & OCTOBER, 1972

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
BC-1	7	8,800	2,000	4,360	7	2,600	100	620
BC-1-A	1	470	470	470	1	56	56	56
BC-2	7	18,000	350	4,090	7	3,300	90	580
BC-3	1	10,000	10,000	10,000	1	1,200	1,200	1,200
BC-4	1	12,000	12,000	12,000	1	1,200	1,200	1,200
BC-5	1	25,000	25,000	25,000	1	1,400	1,400	1,400
BC-6	1	42,000	42,000	42,000	1	2,600	2,600	2,600
BC-7	1	85,000	85,000	85,000	1	5,000	5,000	5,000
TG-1	1	150	150	150	1	16	16	16
BC-8	1	170,000	170,000	170,000	1	140,000	140,000	140,000
BC-9	1	160,000	160,000	160,000	1	34,000	34,000	34,000
BC-10	1	100	100	100	1	5	5	5

Comparison With Proposed Class "B_3" Standard

As the three South Platte River surveys have shown, there has been no violation of the present Class "A" stream standard in the reach upstream from the Union Avenue Bridge (SP-1). However, a primary concern is to check the survey results against the proposed "B_3" stream standard for this same reach.

In order to compare the bacteriological results from the three surveys with the proposed "B_3" stream classification for fecal coliforms, it is necessary to plot the arithmetic average of five consecutive samples at each station, choosing the sample grouping which will produce the highest average fecal coliform count. To compare total coliform values with the "B_3" standard, the arithmetic average of total coliform counts for all sample days of the month must be calculated and plotted. These two plots have been made for each of the three surveys in Figures 8, 9, and 10 respectively.

When the results of Figures 8, 9, and 10 are compared to the total coliform standard under the proposed "B_3" classification, it is observed that all total coliform concentrations were in compliance at all stations during the May survey. The same was the case during the July survey with the exception of the Belleview Avenue station (SP-2). As discussed later, this high value is thought to be due to rainfall effects. During the September survey the only station showing a total coliform concentration in excess of the "B_3" standard was SP-29, located just below the confluence with Brush Creek. The cause of the high total coliform concentration is attributable to either the discharge from the filter sand washing operation at the Kassler Water Treatment Plant or the discharge coming down Brush Creek from the Martin-Marietta Company. The exact cause was not conclusively identified.

Fecal coliform concentrations were found to be within the "B_3" compliance-level at all but one station (SP-1) during the September and May surveys. An unexplained high fecal coliform count (320 per 100 ml) at SP-1 on September 25 caused the calculated five-day average value to exceed the "B_3" level at this station during September. During the May survey, only two samples were collected at SP-1, as opposed to the five which are required by the "B_3" standard. The results at this station during May must, therefore, be considered questionable.

During the July survey, non-compliance levels were observed at four stations:

(1)	Union Avenue	(SP-1)
(2)	Belleview Avenue	(SP-2)
(3)	150 yards downstream from the Bowles Avenue Bridge	(SP-6)
(4)	Bowles Avenue	(SP-7)

The explanations for these violations are discussed in the following section under rainfall effects.

FIGURE 8

Average Total and Fecal Coliform Concentrations vs
River Miles For May, 1972 Survey

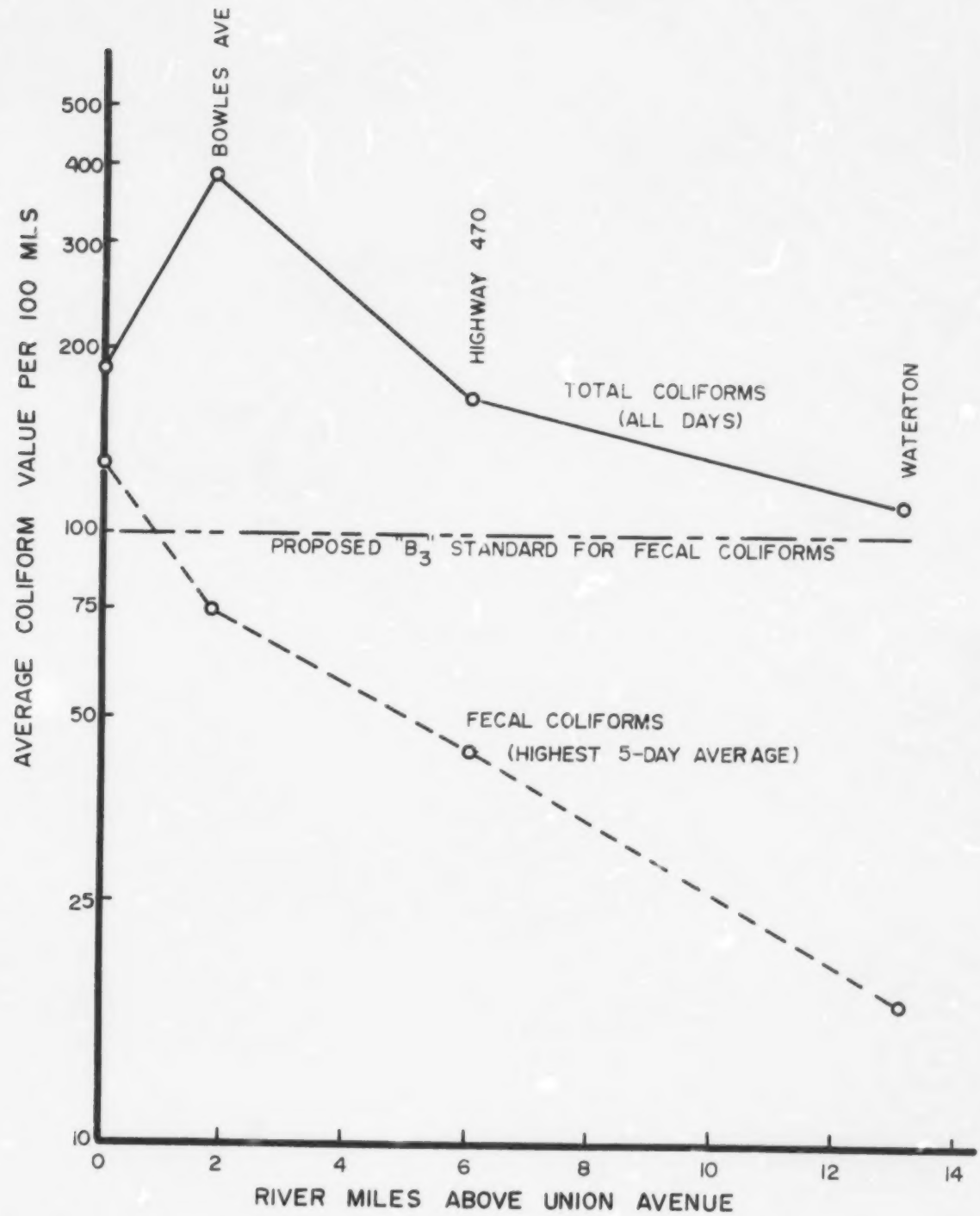


FIGURE 9

Average Total and Fecal Coliform Concentrations vs River Miles For July, 1972 Survey

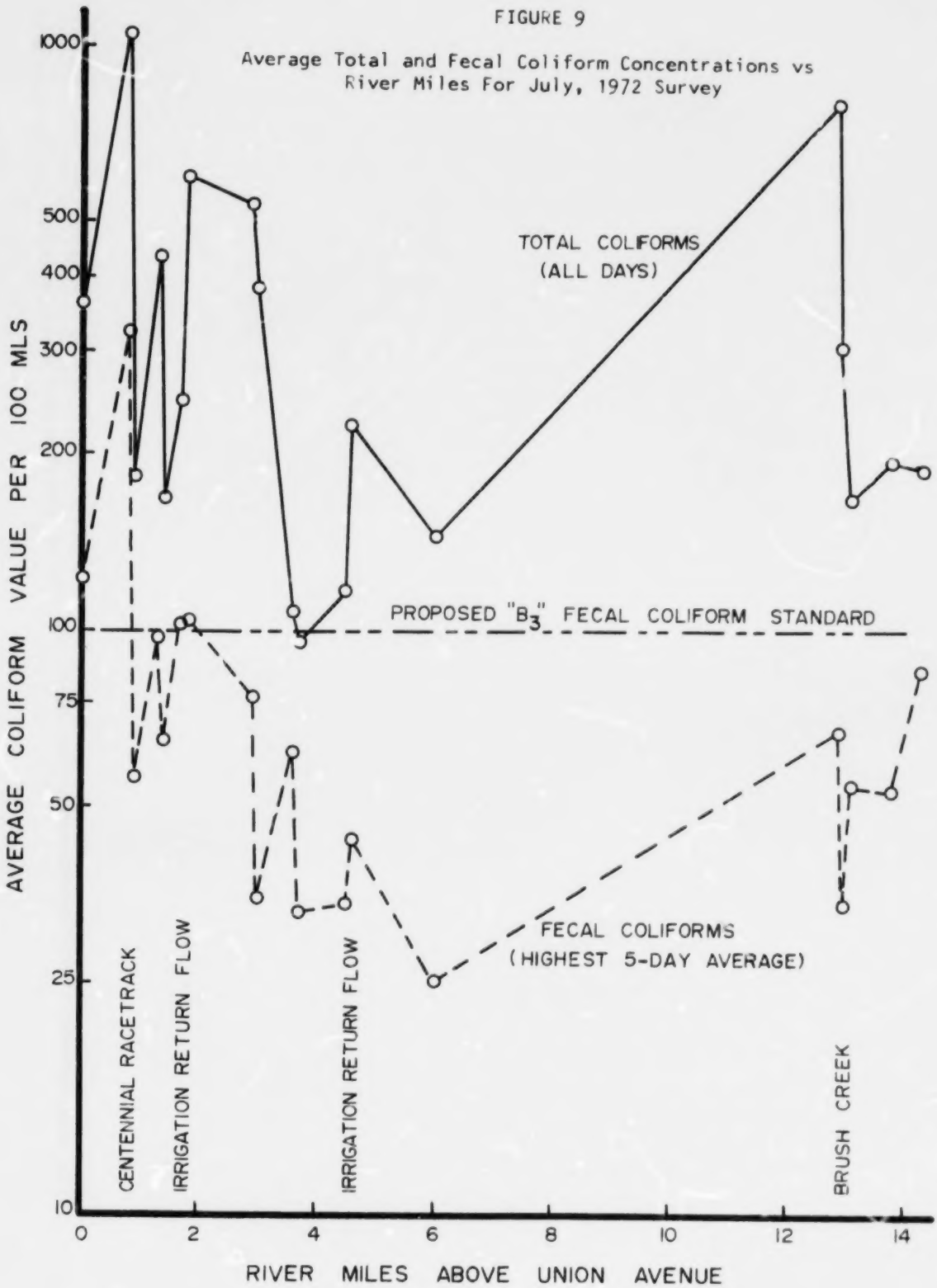
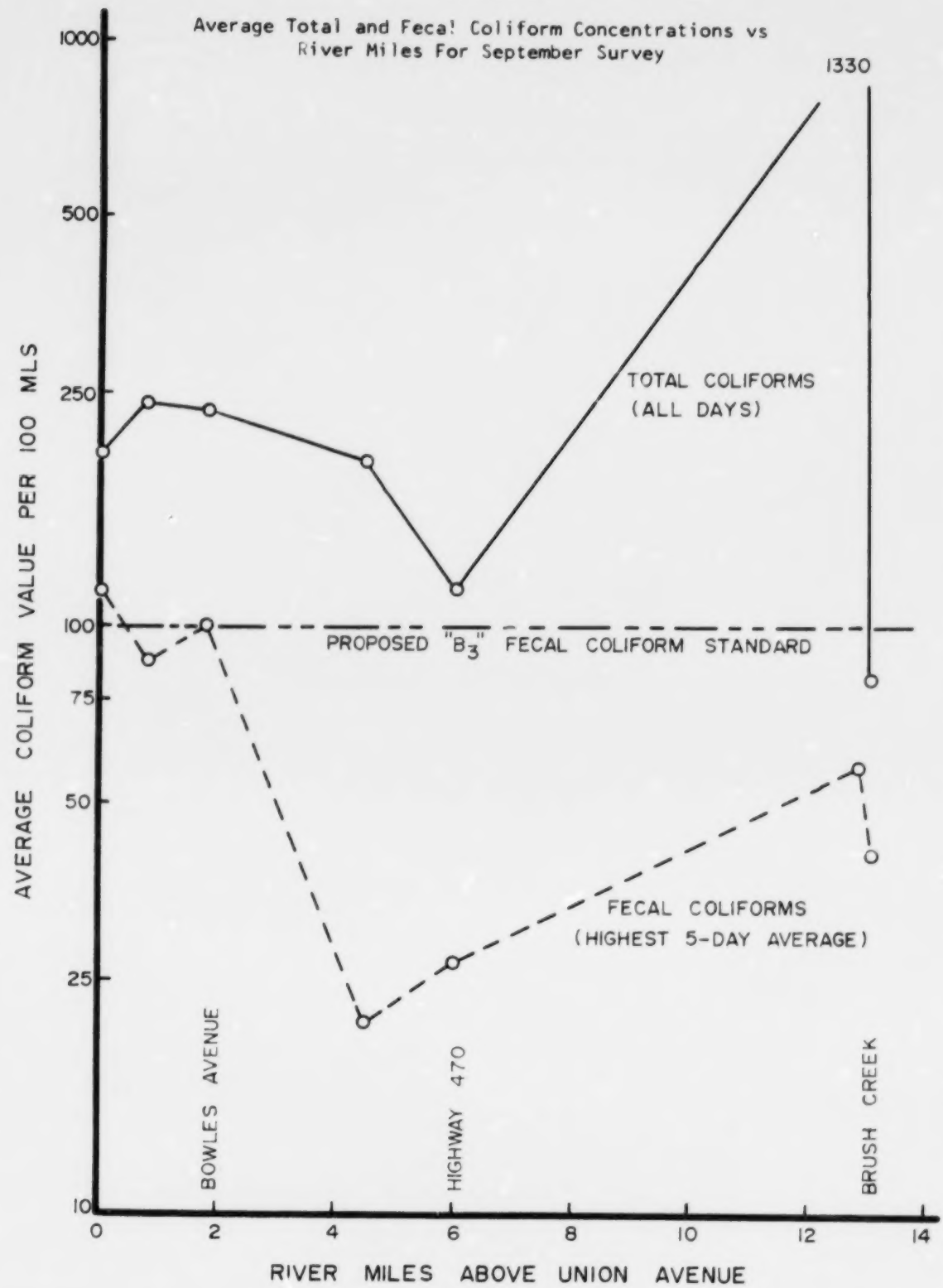


FIGURE 10


Average Total and Fecal Coliform Concentrations vs
River Miles For September Survey
1330
1000
500
250
100
75
50
25
10
AVERAGE COLIFORM VALUE PER 100 MLS
TOTAL COLIFORMS
(ALL DAYS)
PROPOSED "B3" FECAL COLIFORM STANDARD
FECAL COLIFORMS
(HIGHEST 5-DAY AVERAGE)
BOWLES AVENUE
HIGHWAY 470
BRUSH CREEK
0
2
4
6
8
10
12
14
RIVER MILES ABOVE UNION AVENUE

An arithmetic average concentration of 222 fecal coliforms per 100 ml was also obtained at the Hamilton Street Bridge (SP-0). However, this location is downstream from that reach of the South Platte River for which an upgrading to the "B_3" classification is proposed.

Rainfall Effects

Rainfall on the upper South Platte drainage basin has been suggested as one of the possible reasons for the bacteriological degradation of the river during part of the July stream survey. Significant rainfall occurred throughout the survey area on July 17 and in the upper foothills area on July 18. In order to determine the impact of this rainfall and the associated surface runoff on the river water quality, bacteriological data for only these two days has been listed in Table 5 and plotted as an average in Figure 11. All other data for the July survey is listed and plotted in Table 6 and Figure 12, respectively.

An examination of Figures 11 and 12 reveals that total and fecal coliform densities were higher by as much as a factor of six at station SP-19 (RM4.6) on the days affected by the rainfall when compared to data from days unaffected by rainfall. This trend is discernible to a less extent at most of the other stations. In particular, station SP-2 (RM 0.8) which is located about 100 feet below the discharge from the Centennial Racetrack horsebarns (identified during the foot reconnaissance) had unusually high coliform concentrations due to increased surface runoff from these barns. A similar condition existed at stations SP-6 and SP-7 (RM 1.7 and 1.8, respectively) below the reach of stream to which several small runoff sources (irrigation return flows) are tributary. It is likely that higher than normal coliform concentrations will be found in the upper South Platte during most periods of significant rainfall because of runoff from adjacent urban and agricultural lands.

If the proposed "B_3" compliance level is to be achieved the surface runoff from the Centennial Racetrack horsebarns must be prevented from entering the river. A small leaching pond would adequately serve to catch this runoff under most conditions. The other reach of stream in violation of the "B_3" standard (RM 1.7 to 1.8) during runoff conditions would not be so ammeanable to control and/or abatement action because of the scattered locations of the surface runoff sources (including irrigation return water) in the immediate residential area. The Dumb Friends League maintains an animal shelter near the ditch carrying this surface runoff to the river, and any wastewater sources at the shelter should be controlled to prevent fecal coliform contamination of nearby surface waters. Since the proposed "B_3" standard was exceeded by only about 2% due to the sources mentioned above, it is unlikely that severe bacteriological pollution of the South Platte River in this reach (RM 1.7-1.8) will occur even during periods of rainfall.

FIGURE 11

Log-Mean Total and Fecal Coliform Concentrations vs River Miles For Days Affected By Rainfall---July 17-18, 1972

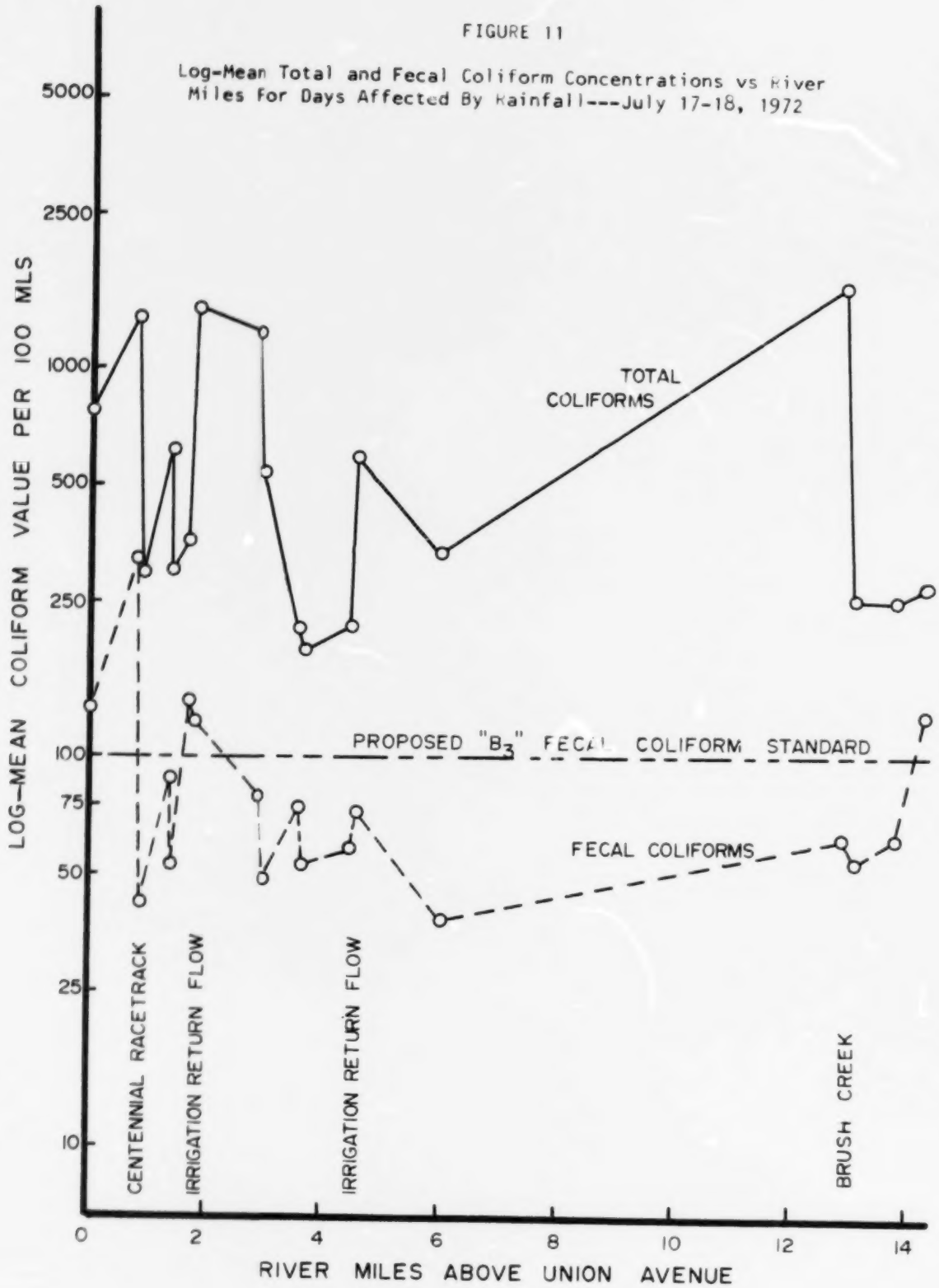


TABLE 5

SUMMARY OF TOTAL AND FECAL COLIFORM CONCENTRATIONS
FOR SELECTED STATIONS ON THE SOUTH PLATTE RIVER
FOR DAYS AFFECTED BY RAINFALL - JULY 17 AND 18, 1972

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
SP-1	2	1200	500	775	2	190	90	131
SP-2	2	5700	320	1350	2	1300	80	322
SP-3	2	320	270	294	2	60	30	42
SP-4	2	1800	210	615	2	150	52	88
SP-5	2	360	250	300	2	55	52	53
SP-6	2	450	280	355	2	200	97	139
SP-7	2	2700	740	1413	2	260	57	122
SP-14	2	2100	720	1230	2	250	25	79
SP-15	2	1700	170	538	2	57	40	48
SP-16	2	290	160	215	2	100	55	74
SP-17	2	210	170	189	2	80	35	53
SP-18	2	240	190	216	2	75	45	58
SP-19	2	830	410	583	2	130	40	72
SP-25	2	470	240	336	2	40	37	38
SP-29	2	2600	1000	1612	2	100	39	62

Table 5

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
SP-30	2	290	230	258	2	62	47	54
SP-31	2	290	220	253	2	78	50	62
SP-32	2	330	230	275	2	150	110	128

FIGURE 12

Log-Mean Total and Fecal Coliform Concentrations vs River Miles
For Days Unaffected By Rainfall---July 12, 13, 14, 19, 20, 1972

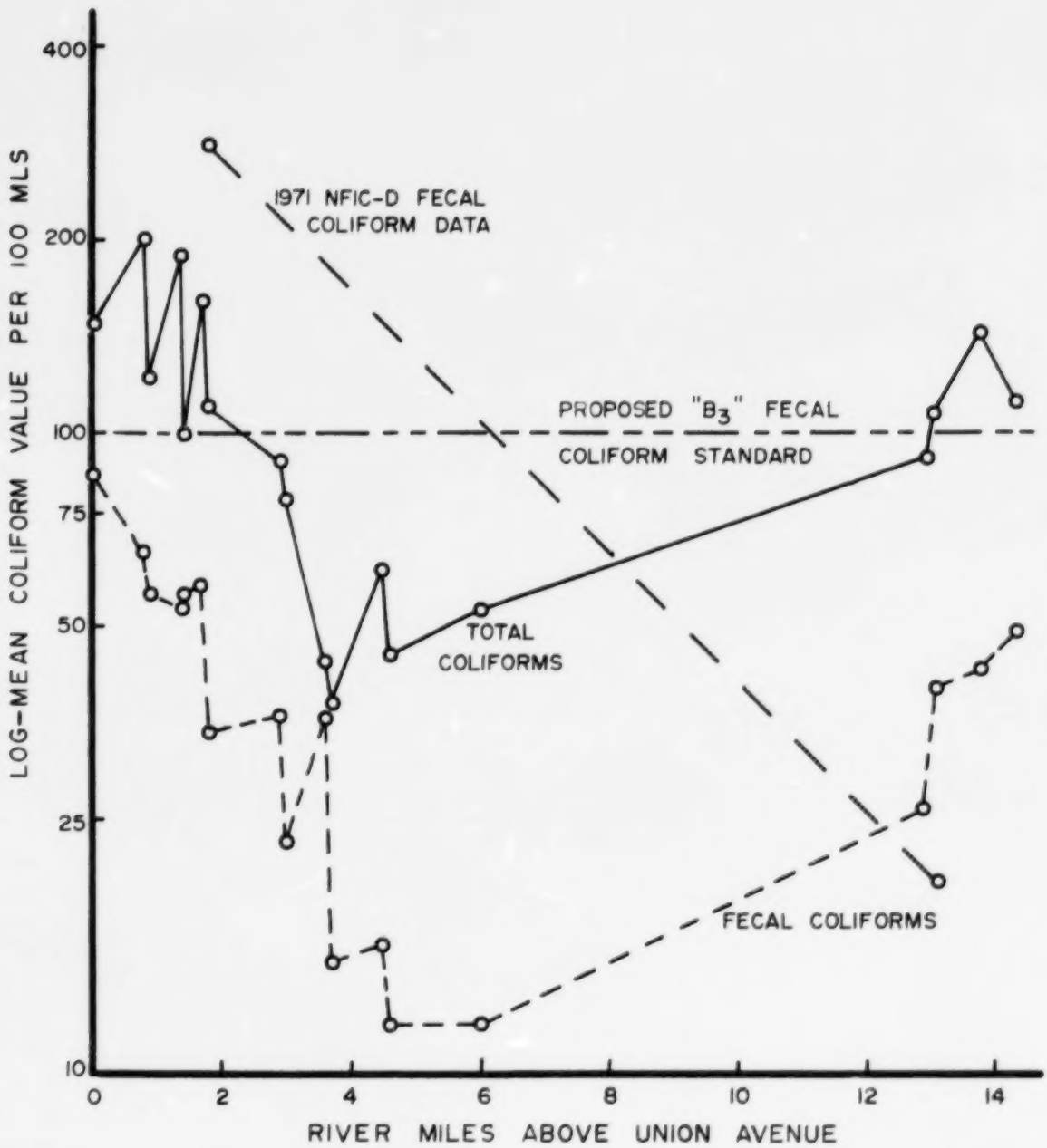


TABLE 6

SUMMARY OF TOTAL AND FECAL COLIFORM CONCENTRATIONS
FOR SELECTED STATIONS ON THE SOUTH PLATTE RIVER
FOR DAYS UNAFFECTED BY RAINFALL - JULY 12,13,14,19 AND 20, 1972

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
SP-1	5	370	100	149	5	230	30	86
SP-2	5	640	65	200	5	100	28	65
SP-3	5	260	67	122	5	72	32	56
SP-4	5	330	110	189	5	180	19	53
SP-5	5	210	45	99	5	94	28	56
SP-6	5	400	68	160	5	120	39	58
SP-7	5	310	34	110	5	110	8	34
SP-14	4	140	46	90	4	44	25	36
SP-15	4	180	18	79	4	32	15	23
SP-16	4	84	25	44	4	62	20	36
SP-17	4	78	16	38	4	32	8	15
SP-18	5	130	22	61	5	24	10	16
SP-19	5	120	17	45	5	22	2	12
SP-25	5	100	29	53	5	27	4	12
SP-29	4	770	4	91	4	150	4	26

Table 6

Sta. #	Total Coliforms/100 ml				Fecal Coliforms/100 ml			
	# Samples	Maximum	Minimum	Log-Mean Value	# Samples	Maximum	Minimum	Log-Mean Value
SP-30	5	260	40	107	5	110	16	40
SP-31	3	220	88	143	3	72	33	43
SP-32	3	210	68	111	3	56	51	54

Comparison With Earlier Survey

The National Field Investigations Center - Denver (NFIC-D) conducted a short term water quality survey on the upper South Platte River in late August, 1971 (Ref. 3). During that survey three bacteriological samples were collected at Bowles Avenue (SP-7) and at Waterton (SP-30). The log-mean values for total and fecal coliforms were 1200 per 100 mls and 280 per 100 mls, respectively, at Bowles Avenue and 580 per 100 mls and 20 per 100 mls, respectively, at Waterton. The fecal coliform log-mean values for the NFIC-D survey are shown by the dotted line in Figure 12. Also shown in Figure 12 are the log-mean fecal coliform values determined during the Region VIII survey of July, 1972, for only those days unaffected by rainfall. The fecal coliform data from the July survey indicates a two-fold decrease in concentration at Bowles Avenue (SP-7) when compared to results from the May and September surveys, and an eight-fold reduction when compared to the 1971 NFIC-D survey. A variety of explanations are possible for the differences in the survey results, including insufficient data collection during the NFIC-D survey, variations in river and wastewater flows, underground seepage, construction in the survey area, and other factors. The fact that the river flow in July, 1972 was only 50% of the flow in August, 1971 (during the NFIC-D survey) may be the most plausible explanation, however.

SECTION V

Conclusions and Recommendations

The survey findings which relate to the occurrance and distribution of total and fecal coliforms are the following:

1. The existing fecal coliform standard for that portion of the river classified as a potable water supply (Class "A") was not exceeded during the May, July, or September surveys.

2. The proposed fecal coliform standard for body-contact water recreation (Class "B_3") was exceeded at one out of four stations in May, four out of nineteen stations in July, and one out of seven stations in September.

3. The proposed total coliform standard (Class "B_3") was exceeded at no stations in May, 1 out of 19 stations in July, and one out of seven stations in September.

4. Violations of the proposed total and fecal coliform standards (Class "B_3") during the July survey may be attributed to the occurrance of rainfall in the survey area on July 17 and 18.

5. Total and fecal coliform concentrations in the upstream Waterton area (RM 13.1) were higher than in the lower stream reach (RM 6.0) because of discharges from the Martin-Marietta Company (via Brush Creek) and other undefined sources further upstream. The observed

coliform concentrations near Waterton did not exceed the proposed "B_3" compliance level, however.

6. Inadequately treated domestic sewage from the Evergreen, Colorado, area produces gross bacteriological pollution in Bear Creek (14,000 fecal coliforms per 100 mls) which exceeds the present Class "A" stream standard. An expansion program is being developed at this facility and should abate much of the existing pollution.

7. Data from the three surveys of May, July, and September does not confirm the high fecal coliform counts found in the upper South Platte River at Bowles Avenue (RM 1.8) during the September, 1971, NFIC-D survey. Variation in river flow is the most plausible explanation for the differences in coliform concentrations.

8. The upstream reach of the South Platte River above the Union Avenue Bridge (SP-1) meets the "B_3" standard for body-contact water recreation at most times except during periods of storm runoff. Abatement actions necessary to achieve the proposed "B_3" bacteriological standard as well as the present narrative standard at all times (except during major runoff periods) are the following:

   (a) Control the periodic discharge from the Centennial Racetrack horse barns by diversion into a leaching pond.

   (b) Construct a settling pond to hold the suspended solids contained in the wastewater from the filter sand washing operation at the Kassler Water Treatment Plant.

If these abatement actions can be effected, a "B_3" classification of this reach of the South Platte River is feasible.

SECTION VI

Acknowledgements

The assistance and cooperation of the personnel at the Littleton, Colorado Sewage Treatment Plant is gratefully acknowledged.

SECTION VII

References

1. Colorado Water Quality Standards Summary, Water Pollution Control Commission, Colorado Department of Health, May 1, 1972.

2. Accomplishment Plan - Water Quality, Region VIII, South Platte River Basin, by the Environmental Protection Agency, Rocky Mountain - Prairie Region, Denver, Colorado, June 5, 1972.

3. Report on Water Quality Investigations in the South Platte River Basin, Colorado, 1971-72 by National Field Investigations Center - Denver and Region VIII, Denver, Colorado, June, 1972.

SECTION VIII

Appendix A

Data Summaries

TABLE 1

SOUTH PLATTE RIVER SURVEY DATA

MAY, 1972

Station #	Date	Time	Coliform Counts/100 ml	
			Total	Fecal
SP-0	5-18	0930	5600	480
	5-22	1110	180	160
	5-23	1236	180	27
SP-1	5-22	0950	200	170
	5-23	1152	170	90
SP-7	5-15	1525	72	62
	5-16	1207	140	60
	5-18	1125	1100	130
	5-22	1020	430	80
	5-23	0930	170	45
SP-25	5-15	1615	90	5
	5-16	1110	47	24
	5-18	1025	280	110
	5-22	1005	220	30
	5-23	0900	200	50
SP-30	5-15	1600	10	< 5
	5-16	1130	25	6
	5-18	1045	120	25
	5-22	0955	130	30
	5-23	0915	270	22

TABLE 2

SOUTH PLATTE RIVER SURVEY DATA

JULY, 1972

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml		Chlorine Residual mg/l
				Total	Fecal	
SP-1	7-12	0943	17	150	100	-
	7-13	0956	18.5	100	84	-
	7-14	0820	16	120	30	-
	7-17	0942	14	1200	190	-
	7-18	0927	15.5	500	90	-
	7-19	0842	16	370	230	-
	7-20	0821	16.5	110	80	-
SP-2	7-12	0957	17	180	28	-
	7-13	0947	18.5	640	100	-
	7-14	0826	16	65	52	-
	7-17	0949	14	320	80	-
	7-18	0935	15	5700	1300	-
	7-19	0849	16.5	330	72	-
	7-20	0831	16.5	130	110	-
SP-3	7-12	1008	17	67	32	-
	7-13	0937	19	85	70	-
	7-14	0833	16	140	56	-
	7-17	1006	15.5	320	30	-
	7-18	0943	15	270	60	-
	7-19	0858	16	260	72	-
	7-20	0842	16	130	60	-

Table 2

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml Total	Coliform Counts/100 ml Fecal	Chlorine Residual mg/l
SP-4	7-12	1056	18	110	19	-
	7-13	0930	19	160	48	-
	7-14	0838	16.5	330	180	-
	7-17	1013	16	1800	150	-
	7-18	0950	15.5	210	52	-
	7-19	0903	16.5	320	60	-
	7-20	0848	16	130	44	-
SP-5	7-12	1101	18.5	45	28	-
	7-13	0925	18	74	55	-
	7-14	0840	15.5	86	74	-
	7-17	1016	15	360	52	-
	7-18	0953	15	250	55	-
	7-19	0904	16.5	210	52	-
	7-20	0851	15.5	160	94	-
SP-6	7-12	1124	19	95	40	-
	7-13	0916	19	130	70	-
	7-14	0847	15.5	68	39	-
	7-17	1028	14.5	450	200	-
	7-18	1007	16.5	280	97	-
	7-19	0918	16.5	400	52	-
	7-20	0906	16.5	310	120	-

Table 2

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml Total	Coliform Counts/100 ml Fecal	Chlorine Residual mg/l
SP-7	7-12	1132	19	34	8	-
	7-13	0908	18.5	100	29	-
	7-14	0854	15.5	88	40	-
	7-17	1023	15	2700	260	-
	7-18	1000	15.5	740	57	-
	7-19	0911	17	310	48	-
	7-20	0858	16	170	110	-
SP-14	7-13	0943	-	100	40	-
	7-14	0943	16	46	25	-
	7-17	1110	14.5	2100	250	-
	7-18	1025	16	720	25	-
	7-19	0942	17	100	44	-
	7-20	0933	16.5	140	40	-
SP-15	7-13	0915	-	71	21	-
	7-17	1123	14.5	1700	40	-
	7-19	0951	17.5	170	30	-
	7-20	0943	16.5	180	32	-
	7-14	0953	16.5	18	15	-
	7-18	1035	15.5	170	57	-
SP-16	7-13	1044	19	84	62	-
	7-14	1037	18.5	43	42	-
	7-17	1330	15	290	100	-
	7-18	1120	17	160	55	-
	7-19	1034	18	25	20	-
	7-20	1033	17	42	33	-

Table 2

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml Total	Fecal	Chlorine Residual mg/l
SP-17	7-13	1046	19	16	26	-
	7-14	1040	17.5	25	8	-
	7-17	1337	15	210	80	-
	7-18	1126	16	170	35	-
	7-19	1038	18	70	8	-
	7-20	1038	17	78	32	-
SP-18	7-12	1143	17.5	29	10	-
	7-13	1022	17	130	24	-
	7-14	1019	16.5	22	10	-
	7-17	1132	14	240	75	-
	7-18	1047	15	190	45	-
	7-19	1002	17	84	19	-
	7-20	0955	16.5	120	21	-
SP-19	7-12	1152	17	19	2	-
	7-13	1013	17.5	120	22	-
	7-14	1014	16	17	17	-
	7-17	1142	14	830	130	-
	7-18	1056	15	410	40	-
	7-19	1010	17	120	20	-
	7-20	1002	16	42	14	-
SP-25	7-12	1205	16.5	29	4	-
	7-13	1201	17.5	40	24	-
	7-14	1212	17	40	9	-
	7-17	1152	14	240	40	-
	7-18	1103	14.5	470	37	-
	7-19	1017	17	90	27	-
	7-20	1016	17	100	13	-

Table 2

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml Total	Coliform Counts/100 ml Fecal	Chlorine Residual mg/l
SP-29	7-13	1140	16	76	20	-
	7-14	1120	15.5	<4	<4	-
	7-17	1410	13.5	2600	100	-
	7-18	1315	16	1000	39	0.0
	7-19	1252	18.5	770	40	-
	7-20	1308	16	300	150	0.15
SP-29-A	7-18	1322	26.5	4700	63	0.0
	7-19	1255	28.0	5400	95	-
	7-20	1322	24.0	140	<4	0.5-1.0
SP-29-B	7-18	1327	15.5	280	25	-
	7-19	1259	17	400	37	-
	7-20	1330	16	220	40	-
SP-30	7-12	1222	16	110	50	-
	7-13	1124	14.5	40	32	-
	7-14	1106	14.5	81	36	-
	7-17	1400	13.5	230	62	-
	7-18	1303	15	290	47	-
	7-19	1237	17	150	16	-
	7-20	1258	15	260	110	-
SP-31	7-14	1153	14	88	34	-
	7-17	1425	13	290	78	-
	7-18	1349	14.5	220	50	-
	7-19	1317	16	150	33	-
	7-20	1402	15.5	220	72	-

Table 2

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml		Chlorine Residual mg/l
				Total	Fecal	
SP-32	7-14	1146	14	68	56	-
	7-17	1432	12.5	330	110	-
	7-18	1355	15	230	150	-
	7-19	1325	16	95	51	-
	7-20	1410	15.5	210	56	-

TABLE 3

SOUTH PLATTE RIVER SURVEY DATA

SEPTEMBER, 1972

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml		Chlorine Residual mg/l
				Total	Fecal	
SP-1	9-25	1100	11.5	330	320	-
	9-26	1125	11.5	320	90	-
	9-27	1035	14	92	60	-
	9-28	0945	13	150	65	-
	9-29	1015	11.5	96	40	-
SP-2	9-25	1047	11.5	380	180	-
	9-26	1110	11.5	330	100	-
	9-27	1027	13.5	150	60	-
	9-28	0930	12	200	70	-
	9-29	1010	11.5	140	23	-
SP-7	9-25	1113	12	450	170	-
	9-26	1055	12	290	170	-
	9-27	1020	13	180	76	-
	9-28	0920	12	180	48	-
	9-29	0955	11	68	36	-
SP-18	9-25	1157	13.5	650	12	-
	9-26	1045	12	89	14	-
	9-27	1005	12.5	68	40	-
	9-28	0910	12	62	19	-
	9-29	0945	11	88	20	-

Table 3

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml Total	Coliform Counts/100 ml Fecal	Chlorine Residual mg/l
SP-25	9-25	1140	12	130	40	-
	9-26	1035	12	120	24	-
	9-27	0956	12.5	120	29	-
	9-28	0855	13	44	14	-
	9-29	0930	11	160	28	-
SP-29	9-25	1230	17.5	1000	44	0.0
	9-26	1005	16.5	260	25	0.3
	9-27	0926	15.5	100	44	0.5
	9-28	0830	12	2700	45	0.1
	9-29	0920	13.5	2600	130	~ 0.1
SP-29-A	9-27	0915	17.5	59	9	0.75
SP-30	9-25	1244	13	100	12	-
	9-26	0930	11	110	76	-
	9-27	0901	10	61	45	-
	9-28	0810	10.5	63	38	-
	9-29	0900	9.5	76	32	-
CC-1	9-28	1020	13	4800	260	-
Cherry Creek at University Ave. Bridge	9-29	1050	13.5	30000	350	-

TABLE 4

BEAR CREEK SURVEY DATA

Station #	Date	Time	Water Temp. °C	Coliform Counts/100 ml Total	Coliform Counts/100 ml Fecal	Chlorine Residual mg/l
BC-1	9-25	1412	11.5	4900	220	-
	9-26	1330	12	2000	370	-
	9-27	0823	7.5	7100	2600	-
	9-28	1100	-	8800	2100	-
	9-29	0825	8	4400	1200	-
	9-29	1505	12.5	3000	100	-
	10-5	0824	10.5	3700	630	-
BC-1-A	10-5	0835	11	470	56	-
BC-2	9-25	1404	11	2400	170	-
	9-26	1320	12	2300	260	-
	9-27	0817	7	8500	3300	-
	9-28	1055	10	18000	2000	-
	9-29	0815	8	7900	1100	-
	9-29	1500	12	350	90	-
	10-5	0844	10.5	8200	730	-
BC-3	10-5	0906	10	10000	1200	-
BC-4	10-5	0930	10	12000	1200	-
BC-5	10-5	0943	10	25000	1400	-
BC-6	10-5	1025	10	42000	2600	0.0
BC-7	10-5	1041	10	85000	5000	-
TG-1	10-5	1206	11	150	16	0.0
BC-8	10-5	1117	11.5	170000	140000	-
BC-9	10-5	1151	11.5	160000	34000	-
BC-10	10-5	1132	10.5	100	5	-

SOUTH PLATTE RIVER SAMPLE STATION DESCRIPTIONS

TABLE 1

Station Number	River Mileage	Location	Sample Point Description
SP-0	-2.5	Hamilton Street Bridge	East bank between Hamilton & Hampden St. bridges
SP-1	0.0	Union Avenue Bridge Just upstream from Littleton STP discharge	Upstream side of bridge
SP-2	0.8	Belleview Avenue Bridge	Downstream side of bridge near west bank
SP-3	0.9	50 yards upstream from Belleview Bridge	West bank approx. 30 ft. upstream from drainage ditch from Centennial Racetrack
SP-4	1.3	100 yards upstream from Crestline Ave. Bridge	West bank approx. 50 ft. below drainage ditch effluent
SP-5	1.4	120 yards upstream from Crestline Ave. Bridge	West bank approx. 50 ft. above drainage ditch effluent
SP-6	1.7	150 yards downstream from Bowles Ave. Bridge	West bank approx. 30 ft. below drainage pipe effluent
SP-7	1.8	Bowles Avenue Bridge	Downstream side of bridge
SP-14	2.9	100 ft. downstream from Lee Gulch	East bank of river
SP-15	3.0	150 yards upstream from Lee Gulch	East bank of river
SP-16	3.6	1.8 miles above Bowles Avenue	West bank approx. 150 yards below small creek
SP-17	3.7	1.9 miles above Bowles Avenue Bridge	West bank approx. 100 ft. upstream from small creek

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Table 1

Station Number	River Mileage	Location	Sample Point Description
SP-18	4.5	Cooley Gravel Company Bridge	Upstream side of bridge
SP-19	4.55	50 yards upstream from Cooley Gravel Co. Bridge	East bank 50 ft. above small drainage ditch
SP-25	6.0	Highway 470 Bridge	Upstream side of bridge
SP-29	12.9	30 yards downstream from Brush Creek	North bank
SP-29-A	12.9	Brush Creek - 10 ft. above confluence with South Platte River	Middle of Brush Creek
SP-29-B	12.9	South Platte - 5 ft. above confluence with Brush Creek	North Bank
SP-30	13.1	USGS Gaging Station at Waterton	North Bank
SP-31	13.8	Low-Head Diversion Dam	North end of dam
SP-32	14.3	Denver Water Board Aquaduct over South Platte River	North bank of river

BEAR CREEK SAMPLE STATION DESCRIPTIONS

TABLE 2

Station Number	River Mileage	Location	Sample Point Description
BC-1	10.7	Soda Lake Road Bridge below Morrison, Colorado	South bank of stream, 10 ft. upstream from bridge
BC-1-A	11.1	Mount Vernon Creek in middle of Morrison	5 ft. above confluence with Bear Creek
BC-2	11.4	USGS - Gaging Station - 150 ft. upstream from bridge on Colo. #8	At the gaging station on north bank
BC-3	12.0	First road turnout above Morrison on Highway #74	North bank on the rocks
BC-4	14.4	About 1/2 mile below Idledale, Colorado	North bank of creek
BC-5	15.5	Little Park, 1/4 mile above Idledale	West end of Little Park on the north bank
BC-6	18.7	100 yds. downstream from Sewage Treatment Plant Discharge	Middle of Low Head Dam, 10 ft. above Kerr Gulch
BC-7	19.1	250 ft. inside O'Fallon Mtn. Park - 250 yds. above STP discharge	East bank on the rocks
TG-1	20.6	Troublesome Gulch Creek, 150 ft. above confluence with Bear Creek	West bank, 40 ft. upstream from Highway #74 bridge
BC-8	20.9	1/4 mile upstream from Kittredge, Colorado at K. I. Skaddon Driveway	North bank
BC-9	21.9	1/4 mile below Evergreen city limits	Upstream side of driveway bridge at the J. Corbin residence
BC-10	23.2	100 ft. below Evergreen Lake Dam	South bank of Bear Creek on the gravel bar